CAVERNICOLOUS ONISCIDEA OF ROMANIA

IONEL TABACARU, ANDREI GIURGINCA

Abstract. 35 species of cavernicolous Oniscidea inhabit the caves of Romania. A remarkable aspect of the oniscidean fauna is the high number of endemic species. The endemic species of Oniscidea from Romania form two groups: Carpathian endemites and Dobrogean endemites.

Key words: Oniscidaea, Romanian Caves.

1. INTRODUCTION

Isopoda are one of the most important orders of the Malacostraca by their great number of species (over 10,000), but also by the diversity of structural types and by their various ways of life. The isopods live in seas and oceans, from the sea-shore and the interstitial to abyssal, in surface and subterranean anchialine and fresh waters, and in terrestrial environments. There are also parasitic species on fishes and other Crustaceans, including other Isopoda.

The order Isopoda presents the highest number of suborders among the other orders of the Malacostraca, due to their great diversity of structural types. Following the classifications of various authors, the order Isopoda includes 9, 10 or 11 suborders. In the same time, the structural diversity led some authors to doubt the orders monophyly. Recent cladistics analyses (TABACARU & DANIELOPOL, 1999, 2011, 2012; WILSON, 2009) argue for the monophyly of the Isopoda by numerous synapomorphies: respiratory pleopods, antennule without accessory flagellum, uniramous pereiopods without epipodites, thoraco-abdominal heart, two-phase molting.

There are different opinions regarding the relationships of the order Isopoda with the other orders of the Malacostraca. Some authors consider Isopoda as a sister-group of the order Amphipoda or even regard these two groups of crustaceans as suborders in a sole order, the Edriophthalma. Other authors see the order Isopoda as the sister-group of the order Tanaidacea or the order Cumacea. The most probable hypothesis, in our opinion, regards the Isopoda, order or superorder, as a sister-group with an ensemble of orders of the Malacostraca. In the cladistics analysis made by TABACARU & DANIELOPOL (2011, 2012), the Isopoda are a sister group of the ensemble [(Tanaidacea + Cumacea) + Spelaeogriphacea].

The suborder Oniscidea or Isopoda Terrestria represents one of the most important suborders within the order Isopoda as it is the suborder with the highest number of species and as the only crustacean group that truly conquered the terrestrial environment. The suborder Oniscidea consists of 36 families and, as

pointed by Schmalfuss in the world catalogue of the Oniscidea, 3637 valid species were recorded up to 2004. However, we have to point out that one of the greatest specialists in the terrestrial isopods, the zoologist Albert Vandel, repeatedly considered the Oniscidea as a heterogeneous, polyphyletic, group. In Vandel's opinion, the Tylidae are a phyletic line separated from the other Oniscidea. On the other hand, after describing an aquatic species of the Trichoniscidae, *Cantabroniscus primitivus* Vandel, 1965, he considers it as a persistence of the primitive state and that the Trichoniscidae form the third independent phyletic line, included in the heterogeneous group Oniscidea.

In the present, the inclusion of the Tylidae within the Oniscidea is argued by numerous synapomorphies. Regarding the aquatic way of life, we have to point out that it was found at species from various families of the Oniscidea (TABACARU, 2002), but strong reasons argue against a persistence of the primitive way of life and in favor of a secondary adaptation (TABACARU & DANIELOPOL, 1996, TABACARU, 2002, SCHMALFUSS, 2005).

Among the clear synapomorphies arguing for the monophyly of the Oniscidea, we can emphasize: the reduction of the antennule to three articles, mandibles without a palpus, the reduction of the maxilla to a sole, unitary piece, the reduction of the endopodial blade of the second male pleopode to a basal article of the appendix masculina, the presence of a scale system ensuring the circulation of a liquid on the body surface.

The Oniscidea are certainly a phyletic line which separated early from the other Isopoda. Some characters, it is supposed, point to a common ancestor with that of the suborder Calabozoa.

The Oniscidea inhabit the terrestrial environment beginning with habitats with a high degree of humidity (marine and fresh water shores, marine and fresh water interstitial, endogeous, leaf-litter, humid moss, rotten wood, caves) to relatively arid, steppic, environments. Also, there are myrmecophyllic, termitophyllic and sinanthropic species found in cellars, wood deposits, greenhouses and various plant cultures.

The study of the terrestrial isopods presents a special interest due to their role in the soil biology and their importance in the understanding of the problems regarding the evolution, the adaptation to the environment and the historical biogeography of the terrestrial faunas from various regions.

2. GENERAL VIEW ON THE ONISCIDEAN FAUNA OF ROMANIA

As the first descriptions of Oniscidea collected in Romania were published since the XIXth century (*Trachelipus trilobatus* Stein, 1859, *Trachelipus ater* Budde-Lund, 1896, *Armadillidium jaqueti* Dollfus, 1897) and that there are two volumes belonging to the series "Fauna României" concerning the terrestrial isopods (RADU, 1983, 1985), it might be assumed that this group of crustaceans is

well studied in Romania. Actually, many species are extremely difficult to identify, some species are doubtful and should be revised, respectively re-described or synonymized, while on another hand, in less studied regions or biotopes, there might be new species either for our country or for science. Thus, following the publication of the two volumes from the series "Fauna României", 10 new species for science were discovered and described. Also, from the 120 species included in the aforementioned volumes, for 40 species the author specifies that they were not found in Romania and the presence of some of them is highly improbable. Comparing the inventory of the species recorded from Romania with the world catalogue of the valid species of Oniscidea (SCHMALFUSS, 2003), we can note the following synonymies: *Platyarthrus schoebli* Budde-Lund,1885 syn. *P. reticulatus* Radu, 1959; *Cylisticus transsilvanicus* Verhoeff, 1908 syn. *C. major* Radu, 1951; *Nagurus cristatus* (Dollfus, 1889) syn. *Bifrontonia femina* Radu, 1960; *Trachelipus ater* (Budde-Lund, 1856) syn. *T. vareae* (Radu, 1949); *Trachelipus trilobatus* (Stein, 1859) syn. *T. racovitzai* (Radu, 1948); *Trachelipus ratzeburgii* (Brandt, 1833) syn. *T. bujori* Radu, 1950; *Trachelipus rathkii* (Brandt, 1833) syn. *T. pleonglandulatus* Radu, 1950; *Trachelipus difficilis* (Radu, 1950) syn. *T. waechtleri* Strouhal, 1951; *Trachelipus arcuatus* (Budde-Lund, 1885) syn. *T. pseudoratzeburgi* Verhoeff, 1907; *Porcellionides myrmecophilus* (Stein, 1859) syn. *P. nitidus* (Radu, 1951).

Up to the present, there are 89 species belonging to 29 genera known from Romania (the number of species is written between parentheses): *Ligidium* (3), *Mesoniscus* (1 – with three subspecies), *Caucasonethes* (1), *Hyloniscus* (8), *Biharoniscus* (2), *Trichoniscoides* (1), *Androniscus* (1 – with two subspecies), *Trichoniscus* (8), *Stylohylea* (1), *Haplophthalmus* (10), *Monocyphoniscus* (1), *Banatoniscus* (1), *Thaumatoniscellus* (1), *Buddelundiella* (2), *Trichorina* (1), *Platyathrus* (5), *Halophiloscia* (1), *Chaetophiloscia* (2), *Oniscus* (1), *Cylisticus* (3), *Nagurus* (1), *Protracheoniscus* (3), *Porcellium* (6), *Trachelipus* (10), *Porcellionides* (2), *Leptotrichus* (1), *Porcellio* (4), *Armadillidium* (8), *Kithironiscus* (1).

Among the 14 families recorded in Romania, the Trichoniscidae has the highest number of species (35), followed by the Trachelipodidae with 17 species, Armadillidiidae with 8 species, Porcellionidae with 7 species, Platyarthridae with 6 species, Ligiidae, Cylisticidae and Agnaridae with 3 species each, Buddelundiellidae and Phylosciidae with 2 species each, Mesoniscidae, Halophilosciidae, Oniscidae and Scleropactidae with 1 species each.

Analyzing the Romanian fauna of Oniscidea from a zoogeographic point of view, we have to leave aside the expansive or sinanthropic species such as *Ligidium hypnorum* (Cuvier, 1792), *Hyloniscus riparius* (C.L.Koch, 1838), *Trichoniscus pusillus* Brandt, 1833, *T. pygmaeus* G.O.Sars, 1898, *Haplophthalmus danicus* Budde-Lund, 1880, *Platyarthrus hoffmannseggii* Brandt, 1833, *Oniscus asellus* Linnaeus, 1758, *Cylisticus convexus* (De Geer, 1778), *Porcellionides pruinosus* (Brandt), *Porcellio scaber* Latreille, 1804, *P. laevis* (Latreille, 1804), *P. dilatatus* Brandt, 1833, *P. spinicornis* Say, 1818, *Armadillidium vulgare* Latreille, 1804, *A. nasatum* Budde-Lund, 1885, *Nagurus cristatus* (Dollfus, 1889).

A remarkable aspect of the oniscidean fauna is the high number of endemic species. According to the latest data, 40 endemic species and 4 endemic subspecies are known from Romania. This is, obviously, a high percentage of specific endemicity that can be explained by the high number of cavernicolous species.

Within the zoogeographical analyses, the endemic species are, sometimes, regarded similarly with the autapomorphies or the monophiletic taxa within the phylogenetic analyses, as without a value in establishing the relationships with the fauna of other regions. But the endemic species argue for the age and the isolation of that fauna. However, for the group specialists, the endemic species, by taxonomic studies, can provide important indications concerning the origin and the zoogeographic relationships of the fauna.

In the two "Fauna României" volumes, there are 5 endemic genera: *Ropaloniscus* Radu, 1976, *Bifrontonia* Radu, 1960, *Biharoniscus* Tabacaru, 1963, *Thaumatoniscellus* Tabacaru, 1973 and *Banatoniscus* Tabacaru, 1991. But the genus *Ropaloniscus* was synonymized with *Hyloniscus* Verhoeff, 1908 and the genus *Bifrontonia* with *Nagurus* Holthuis, 1949. The genus *Thaumatoniscellus* was also found in Croatia, with a new, troglobitic, species.

The endemic species of Oniscidea from Romania form two groups: Carpathian endemites and Dobrogea endemites.

Until now, 8 endemic species and 1 endemic subspecies have been described from Dobrogea: *Caucasonetes vandeli* Tabacaru, 1993, *Haplophthalmus orientalis* Radu, Radu & Cadariu, 1956, *H. movilae* Gruia & Giurginca, 1998, *Trichorina dobrogica* Radu, 1964, *Platyarthrus dobrogicus* Radu, 1951, *Leptotrichus pilosus dobrogicus* Radu, 1973, *Trachelipus troglobius* Tabacaru & Boghean, 1989, *Armadillidium tabacarui* Gruia, Javorschi & Sarbu, 1994 and *Kithironiscus dobrogicus* Tabacaru & Giurginca, 2003.

Analyzing the fauna of Oniscidea from Dobrogea, the presence of *Monocyphoniscus babadagensis* Radu, 1965, *Platyarthrus atanassovi* Verhoeff, 1936, *P. coronatus* Radu, 1985 and one endemic species of the genus *Kithironiscus* Schmalfuss, 1995 and the species *Leptotrichus pilosus* Dollfus, 1905 we can underline an obvious close relationship with the East-Balcanic and East-Mediterranean fauna. The presence in Dobrogea of the species *Protracheoniscus scythicus* Demianowicz, 1932, *Armadillidium traiani* Demianowicz, 1932, *A. jaqueti* Dollfus, 1897 points to a relationship with the fauna of regions situated northward to Dobrogea, eastward from River Prut.

From the Romanian Carpathians, 31 endemic species and 4 endemic subspecies are known. Some are typical for a single Carpathian sector only; other species have a wider spreading. From the Eastern Carpathians, 5 endemic species and 2 endemic subspecies are recorded: *Mesoniscus graniger moldavicus* Radu, 1977, *Hyloniscus motasi* (Radu, 1976), *Haplophthalmus medius* Radu, Radu & Cadariu, 1956, *Cylisticus brachyurus* Radu, 1951, *Protracheoniscus politus carpaticus* Verhoeff, 1928, *Trachelipus radui* Tomescu & Olariu, 2000 and *Porcellium transsylvanicum*, Tomescu, Teodor, Ferenti, 2012.

From the Apuseni Mountains, 7 endemic species and 1 endemic subspecies are known: *Mesoniscus graniger dragani* Giurginca, 2003, *Biharoniscus racovitzai* Tabacaru, 1963, *B. fericeus* Tabacaru, 1973, *Haplophthalmus caecus* Radu, Radu & Cadariu, 1956, *H. napocensis* Radu, 1977, *Cylisticus transsylvanicus* Verhoeff, 1905, *Trachelipus ater* (Budde-Lund, 1896), *T. spinulatus* Radu, 1959.

From the Banat Mountains (including the area of the Iron Gates with a remarkable fauna), 4 endemic species are recorded: *Trichoniscoides danubianus* Radu, 1973, *Banatoniscus karbani* Tabacaru, 1991, *Haplophthalmus banaticus* Radu, 1977, *H. ionescui* Radu, 1983.

The highest number of endemic species (11) is recorded from the Southern Carpathians, between the River Olt and the Timiş-Cerna Corridor: *Hyloniscus flammuloides* Tabacaru,1972, *Trichoniscus inferus* Verhoeff, 1908, *T. racovitzai* Tabacaru, 1994, *T. vandeli* Tabacaru, 1996, *T. tuberculatus* Tabacaru, 1996, *T. dancaui* Tabacaru, 1996, *Thaumatoniscellus orghidani* Tabacaru, 1973, *Haplophthalmus tismanicus* Tabacaru, 1970, *Buddelundiella serbani* Tabacaru, 1971, *Trachelipus trilobatus* (Stein, 1859), *Armadillidium banaticum* Verhoeff, 1907.

There are 5 endemic species with a wider spreading in the Carpathians: *Ligidium intermedium* Radu, 1950, *Hyloniscus inflatus* Verhoeff, 1927, *H. siculus* Mehely, 1929, *H. dacicus* Tabacaru, 1972, *Trichoniscus carpaticus* Tabacaru, 1974.

From a zoogeographic point of view, the Romanian fauna of Oniscidea (in its ensemble, but with the exception of Dobrogea) is linked with the fauna of Central Europe. However, the troglobitic elements from the Apuseni Mountains, the Banatului Mountains and from the Southern Carpathians, point to a close relationship with troglobitic elements from the northern part of the Balkan Peninsula. Also, we note the presence at the Iron Gates of the genus *Trichoniscoides* Sars, 1899 which has a predominantly Western European spreading and, as such, this is its eastern spreading limit.

3. SHORT HISTORY OF THE STUDIES ON THE CAVERNICOLOUS ONISCIDEA OF ROMANIA

In the spring of 1898, the German zoologist KARL W. VERHOEFF explored the Peştera Hoților (Thieves' Cave) from Băile Herculane (Räuberhohle bei Herkulesbad) discovering two new species, respectively one species of Diplopoda and one species of terrestrial Isopoda. The Diplopod species proved to be a remarkable troglobitic relict, *Trichopolydesmus eremitis* Verhoeff, 1898, a new genus, type of a new family. The Oniscidea species was described by Verhoeff only after 10 years under the name *Trichoniscus inferus* Verhoeff, 1908 and is a depigmented troglophilic species, but with pigmented ocelli.

A methodic research of the fauna from the Romanian caves began only after Emil Racoviță founded in 1920 the Institute of Speleology from Cluj. In two volumes from "Enumération des grottes visitées", respectively the volume containing the seventh

series (1918-1927), published in 1929, and the volume containing the eights series (1927-1949), published in 1951, are included 483 caves, 250 being on the territory of Romania. The author mentions collecting Isopoda from many Romanian caves, but Racoviță, preoccupied by numerous problems, did not have the time to study this material. Excepting the *Mesoniscus* samples studied by Pierre Alfred Chappuis, the deputy director of the Institute of Speleology, the rest of the Isopoda samples collected from the Romanian caves was lost. In 1944, CHAPPUIS published a study on *Mesoniscus* (a troglophylic and endogeicolous isopod) and established two new subspecies (*M. alpicola vulgaris* Chappuis, 1944 and *M. alpicola meridionalis* Chappuis, 1944), subsequently synonymized (GRUNER & TABACARU, 1963) with the species *Mesoniscus graniger* (Frivaldsky, 1865).

The first troglobitic terrestrial isopod found in Romania is *Haplophthalmus caecus* Radu, 1955. It was discovered in a cave from the Apuseni Mountains by Mihai Şerban (an assistant of Emil Racoviță from 1946 at the Institute of Speleology) and described by Vasile Radu, professor at the Cluj University and director of the Institute of Speleology between 1947 and 1953, who began studying the Isopoda from Romania from 1938.

In 1956, after the reorganization of the Institute of Speleology, I. Tabacaru took over the study of Oniscidea. Studying the samples collected personally or by colleagues, he described new troglobitic species: *Biharoniscus racovitzai* Tabacaru, 1963 (collected in a cave from the Apuseni Mountains by Maria Pintea-Alb from the Cluj Department of the Institute of Speleology), *Biharoniscus fericeus* Tabacaru, 1973 (also from a cave from the Apuseni Mountains), *Banatoniscus karbani* Tabacaru, 1991 (collected in a cave from the Banatului Mountains by Günther Karban – Explorers Speo-Club, Reşiţa), *Caucasonethes vandeli* Tabacaru, 1993 discovered in caves from Southern Dobrogea by the professors Margareta Dumitrescu and Traian Orghidan, and the species *Haplophthalmus tismanicus* Tabacaru, 1970, *Trichoniscus racovitzai* Tabacaru, 1995, *T. vandeli* Tabacaru, 1996, *T. tuberculatus* Tabacaru, 1996 from the Southern Carpathians. Also, we note the small, depigmented and blind species *Thaumatoniscellus orghidani* Tabacaru, 1973, discovered in the lithoclasicolous nearby Topolniţa Cave from Mehedinţi Plateau by Traian Orghidan, the deputy director (from 1956) and then director (1964-1985) of the Institute of Speleology. A new, troglobitic species of the genus *Thaumatoniscellus*, the type of the Thaumatoniscelinae Tabacaru, 1993, was described from a cave from Istria (Croatia).

Also within the Institute of Speleology, the Oniscidea were studied from 1997 by Andrei Giurginca. He investigated especially the genus *Mesoniscus* and described a new subspecies: *M. graniger dragani* Giurginca, 2003. In 2009, he published a monograph: "Aspects concerning the genus *Mesoniscus*. Morphology, Spreading, Historical Biogeography".

With the occasion of a drilling performed in Southern Dobrogea, 3 km away from the Black Sea and 1 km from Mangalia, the geologist Cristian Lascu (from

the Institute of Speleology) discovered a cave, named the Movile Cave by the geographer Traian Constantinescu (from the same institute).

The intensive biospeleological research of this cave led to the discovery of numerous new remarkable taxa, among them the following Oniscidea: *Trachelipus* troglobius Tabacaru & Boghean, 1989, *Armadillidium tabacarui* Gruia, Javorschi & Sarbu, 1994, *Haplophthalmus movilae* Gruia & Giurginca, 1998 and *Kithironiscus dobrogicus* Tabacaru & Giurginca, 2003.

4. INVENTORY OF THE ONISCIDEA FOUND IN THE ROMANIAN CAVES

Suborder **Oniscidea** Latreille, 1802

Family **Ligiidae** Brandt & Ratzeburg, 1831

1. *Ligidium hypnorum* (Cuvier, 1792) – Troglophilous species (eyes big with 120 ommatidia, intensely pigmented). **Distribution**: Europe and Western Asia, introduced in North America (RADU, 1983; SCHMALFUSS, 2003). **Chorology**: Turano-European.

Banat Mountains: Peştera (peştera = cave) Gaura Cornii, Peştera Comarnic, Peştera Grădinca, Peştera Gaura Haiducească (NEGREA & NEGREA, 1977).

Retezat Mountains: Peştera de la Gura Cetății.

Family **Mesoniscidae** Verhoeff, 1908

2. *Mesoniscus graniger graniger* (Frivaldsky, 1865) – Troglophilous species (blind, depigmented). **Distribution**: Slovakia, Romania, Serbia, Bosnia & Hercegovina, Slovenia (GRUNER & TABACARU, 1963; RADU, 1983; SCHMALFUSS, 2003; GIURGINCA, 2003, GIURGINCA, 2009). **Chorology**: Carpatho-Dinaric.

Bihor Mountains: Peştera Zmeilor de la Onceasa, Peştera Fânațe, Peştera Ferice; Peştera Osoi;

Pădurea Craiului Mountains: Peştera Meziad, Peştera din Valea Steazelor, Peştera Hârtopul Bonchii, Peştera Ciur Izbuc, Peştera Cubleş, Peştera Călățea, Peştera Bătrânului, Peştera de sub Peretele din Valea Leşului, Peştera Toderea Fanului, Peştera Corn, Poşiştăul din Dealul Pleş, Peştera Cotuna, Peştera Vântului, Peştera Izbândiş, Peştera Vadul Crişului, Peştera Devențului, Peştera Gălăşeni, Peştera Igrița;

Perşani Mountains (Vârghişului Valley): Caves no. 6, 7, 9, 12, 14 (Peştera Mare de la Mereşti), 16, 23, 32, 34, 38;

Oltului – Grohotişu Mountains (Piatra Craiului Massif) (GIURGINCA & NAE, 2004, GIURGINCA, 2009, NITZU, POPA, GIURGINCA, 2011): Peştera Dracilor, Peştera cu Lilieci, Peştera Dobreşti, Peştera Hoților (Peştera cu Ciuperci), Peştera de Sus din Valea Rea, Peştera Dâmbovicioara (GRUNER & TABACARU, 1963);

Cerna Valley: Cave no. 64 from the Cerna Basin (GIURGINCA, 2009);

Banat Mountains (GRUNER & TABACARU, 1963; DANCĂU & TABACARU, 1964; NEGREA & NEGREA, 1977; NEGREA, NEGREA & KARBAN, 1993; GIURGINCA,

2003, 2009): Peştera Voinicovăţ, Peştera Zamonița, Peştera Filip Gârnic, Peştera din Valea Ceuca, Peştera Topolița, Peştera Gaura cu Muscă, Peştera U Lomu, Peştera de la Gradina Matei, Peştera Gaura Haiducească, Peştera Boilor, Peştera Gaura Porcariului, Peştera Voinii, Peştera de la Vălei, Peştera Ponor Plopa, Peştera Găurile lui Miloi, Peştera cu Apă din Cheile Gârliştei, Peştera Mistreților, Peştera no. 1 din Navesul Mare, Peştera Buhui, Peştera de la Socolovăţ, Peştera de după Cârşă, Peştera 2 Mai, Peştera Popovăţ, Peştera Racoviță, Peştera de sub Cetate II, Peştera Cuptoru Porcului, Peştera Țolosu, Peştera Țapului, Peştera Strâmtă, Peştera Geamănă, Peştera Stârnic, Peştera Comarnic, Peştera Exploratorii 85, Peştera Gaura Turcului, Peştera Gaura Pârşului de la Capul Baci, Peştera Gaura de la Capu Baciului, Peştera Ponor din Sodolul Mare, Peştera Românești.

3. *Mesoniscus graniger dragani* Giurginca, 2003 – Troglophilous species (blind, depigmented). **Distribution**: Romania (Bihor Mountains) (GIURGINCA, 2003, GIURGINCA, 2009). **Chorology**: Romanian endemite.

Bihor Mountains: Valea Sighiştelului (valea = valley): Peştera Măgura, Peştera Pişolca, Peştera Drăcoaia, Peştera Tibocoaia, Peştera Corbasca, Peştera de la Fața Pietrii; Valea Crăiasa: Huda de la Chişcău, Peştera Urşilor de la Chişcău.

Family **Trichoniscidae** Sars, 1899

4. *Caucasonethes vandeli* Tabacaru, 1993 – Troglobitic species (blind, depigmented). **Distribution**: Romania (Dobrogea) (TABACARU, 1993B; SCHMALFUSS, 2003). **Chorology**: Romanian endemite.

Dobrogea: Peştera Liliecilor de la Gura Dobrogei, Peştera de la Casian.

5. *Hyloniscus riparius* (C.L.Koch, 1838) – Troglophilous species (1 ommatidia, pigmented). **Distribution**: Central and Eastern Europe, introduced in North America (RADU, 1983; SCHMALFUSS, 2003). **Chorology**: Balkan-Central European.

Central Dobrogea: Peştera de la Casian, Peştera Liliecilor de la Gura Dobrogei

Bertea Prahova (Aluniş Depression, Subcarpathian Hills, Buzău County, karst on gypsum): Cave no. 2 (NITZU, GIURGINCA, ILIE & VĂNOAICA, 2002).

Mehedinți Mountains: Avenul Gaura Mare

Banat Mountains: Peştera no. 2 din Dealul Cârneală

6. *Hyloniscus transsylvanicus* (Verhoeff, 1901) – Troglophilous species (1 ommatidia, pigmented). **Distribution**: Slovakia, Hungary, Romania, Serbia (RADU, 1983; SCHMALFUSS, 2003). **Chorology**: Central – Southern European.

Mehedinți Mountains: Avenul Gaura Mare

Mehedinți Plateau: Peştera de la Vârful Înalt, Peşterile no. 12 & 14 din Valea Lupşei, Abri near Peştera no. 8 din Valea Lupşei, Peştera din Valea Părului.

Cerna Valley Basin: Peştera Ponorul Pecinişcăi, Peşterile no. 1, 2, 3, 5, 7, 8, 9, 11, 13, 14, 18, 19, 21, 22, 25, 26, 28, 46, 47, 49, 71.

Banat Mountains: Peştera no. 1 din Cariera Nouă, Peştera Grădinca, Peştera Vraşka, Peştera Gaura Haiducească, Peştera Topolița, Peştera Popovăț, Peştera no. 6 de la Cureacița, Peştera de la Izvoru Înfundat, Avenul de la Vranovăț (NEGREA & NEGREA, 1977), Peştera Exploratorii '85, Peştera no. 1 din Valea Comarnicului (NEGREA, NEGREA, KARBAN, 1993).

7. *Hyloniscus dacicus* Tabacaru, 1972 – Troglophilous species (1 ommatidia, pigmented). **Distribution**: Romania (TABACARU, 1972; RADU, 1983; SCHMALFUSS, 2003, GIURGINCA, NAE & POPA, 2006). **Chorology**: Romanian endemite.

Mehedinți Mountains: Avenul de sub Plaiul Gorganului.

Banat Mountains: Peştera Buhui (TABACARU, 1972).

8. *Hyloniscus flammuloides* Tabacaru, 1972 – Troglophilous species (1 ommatidia, pigmented). **Distribution**: Romania (TABACARU, 1972; RADU, 1983; SCHMALFUSS, 2003). **Chorology**: Romanian endemite.

Şureanu Mountains: Peştera Gaura Oanei. **Retezat Massif**: Peştera de la Gura Cetății.

9. *Biharoniscus racovitzai* Tabacaru, 1963 – Troglobitic species (blind, depigmented). **Distribution**: Romania (TABACARU, 1963; RADU, 1983; SCHMALFUSS, 2003). **Chorology**: Romanian endemite.

Codru-Moma Mountains (Apuseni Mountains): Peştera Câmpenească.

10. *Biharoniscus fericeus* Tabacaru, 1973 – Troglobitic species (blind, depigmented). **Distribution**: Romania (TABACARU, 1973; RADU, 1983; SCHMALFUSS, 2003). **Chorology**: Romanian endemite.

Bihor Mountains: Peştera de la Ferice.

11. *Androniscus roseus roseus* (C.L.Koch, 1837) – Troglophilous species (1 ommatidia, depigmented). **Distribution**: from the Eastern France to Romania, north to Southern Germany and south to Northern Italy; not in the Balkan Peninsula) (RADU, 1983; SCHMALFUSS, 2003). **Chorology**: Central European.

Almăj Mountains – Danube Gorges: the species is known from only two caves in our country: Peştera Ponicova and Peştera Veterani (DANCĂU & TABACARU, 1964).

The eastern limit of the Central European spreading of the species *Androniscus roseus* is in Romania and Serbia. The subspecies *A. roseus transsylvanicus* Radu, 1960 was described from the Turzii Gorges and found again in Serbia (KARAMAN AND ČEMERLIĆ, 2000). However, the populations recorded in the caves from the Danube Gorges, belong to the type subspecies. At the request of one of the authors (I. Tabacaru), the well-known isopodologist Hans Strouhal had the amiability to confirm the identification by comparisons with material from the Vienna Museum.

12. *Stylohylea bosniensis* (Verhoeff, 1901) – Troglophilous species. **Distribution**: South-Western Romania, Serbia, Bosnia & Hercegovina, Croatia (SCHMALFUSS, 2003). **Chorology**: West–Balkan.

Banat Mountains: Peştera no. 1 din Cariera Nouă, Peştera Văleaga, Peştera Spânului, Peştera de la Pepa (Gaura Belarecăi) (NEGREA & NEGREA, 1977).

13. *Trichoniscus carpaticus* Tabacaru, 1974 – Troglophilous species (3 ommatidia, pigmented). **Distribution**: Romania (TABACARU, 1974; RADU, 1983; SCHMALFUSS, 2003). **Chorology**: Romanian endemite.

Bihor Mountains: Avenul din Tărtăroaia.

14. *Trichoniscus inferus* (Verhoeff, 1908) – Troglophilous species (3 ommatidia, pigmented). **Distribution**: Romania (VERHOEFF, 1908; DANCĂU & TABACARU, 1964; SCHMALFUSS, 2003). **Chorology**: ? Romanian endemite.

Cerna Valley Basin: Peştera Hoţilor de la Băile Herculane, Peştera lui Adam, Peştera lui Ion Bârzoni, Peştera Soronişte, 5 caves from Sălitrari, 5 caves from Corcoaia, 6 caves from Geanţul Ineleţului.

15. *Trichoniscus* aff. *inferus* – Troglobitic species (blind, depigmented).

Vâlcan Mountains: Peştera de la Mânăstirea Tismana, Peştera Fuşteica, Peştera Râpa Vânătă, Cornetul Vârcanilor, Peştera de la Vârful Lacăului.

Mehedinţi Mountains: Peştera Cloşani, Peştera Lazului, Peştera Cioaca cu Brebenei, Peştera din Poiana Lazului (Peştera lui Mihai Arjoc).

16. *Trichoniscus racovitzai* Tabacaru, 1994 – Troglobitic species (blind, depigmented). **Distribution**: Romania (TABACARU, 1994; SCHMALFUSS, 2003). **Chorology**: Romanian endemite.

Vâlcan Mountains: Peştera de la Gura Plaiului;

Mehedinţi Mountains: Peştera de la Isverna;

Mehedinţi Plateau: Peştera de la Podul Natural, Peştera Bulba, Peştera-aven de la Pietre, Peştera din Valea Parului, Peştera de la Vârfu Înalt (= Peştera Cerna-Vârf), Peştera Babelor (Peştera de la Babie), Peştera Mare de la Balta, Peştera din Dealul Curecea, Peştera Sfodei, Peştera Gramei, Peştera Topolniţa.

17. *Trichoniscus tuberculatus* Tabacaru, 1996 – Troglobitic species (blind, depigmented). **Distribution**: Romania (TABACARU, 1996; SCHMALFUSS, 2003). **Chorology**: Romanian endemite.

Mehedinţi Mountains: Peştera Vacilor de la Cloşani.

18. *Trichoniscus vandeli* Tabacaru, 1996 – Troglobitic species (blind, depigmented). **Distribution**: Romania (TABACARU, 1996; SCHMALFUSS, 2003). **Chorology**: Romanian endemite.

Vâlcan Mountains: Peştera Gruiului. Peştera Pârlazului, Peştera cu Lapte de la Runcu, Peştera din Poiana Nucului (Peştera din Poiana Peşterii), Peştera Boiereasca.

19. *Trichoniscus dancaui* Tabacaru, 1996 – Troglobitic species (with eyes, weakly depigmented). **Distribution**: Romania (TABACARU, 1996; SCHMALFUSS, 2003). **Chorology**: Romanian endemite.

Mehedinți Mountains: Peştera Cloşani, Peştera no. 2 de la Cloşani.

20. *Trichoniscus pygmaeus* Sars, 1899. – Troglophilous species (creamy white, 3 black ocelli). **Distribution**: Europe, Azores, Morocco, SW – Russia, introduced to North America (SCHMALFUSS, 2003). **Chorology:** European

Pădurea Craiului Mountains: Peştera Calului

Banat Mountains: Peşţera no. 1 din Cariera Nouă.

21. *Thaumatoniscellus orghidani* Tabacaru, 1973 – Troglophilous species (blind, depigmented). **Distribution**: Romania (TABACARU, 1973; RADU, 1983; SCHMALFUSS, 2003). **Chorology**: Romanian endemite.

Mehedinți Plateau: lithoclasicolous near the Topolnița Cave.

22. *Monocyphoniscus babadagensis* Radu, 1965 (*Kosswigius* cf. *delattini* Verhoeff, 1941, det. Tabacaru in DUMITRESCU et all., 1965) – Troglophilous species (1 ommatidia, depigmented). **Distribution**: Romania, Bulgaria (RADU, 1983; SCHMALFUSS, 2003). **Chorology**: Euxinic.

South Dobrogea: Peştera Hoţilor de la Limanu (DUMITRESCU et all., 1965).

23. *Banatoniscus karbani* Tabacaru, 1991 – Troglobitic species (blind, depigmented). **Distribution**: Romania (TABACARU, 1991; SCHMALFUSS, 2003). **Chorology**: Romanian endemite.

Banat Mountains: Peşţera no. 1 din Cariera Nouă.

24. *Haplophthalmus caecus* Radu, 1955 – Troglobitic species (blind, depigmented). **Distribution**: Romania (RADU, 1955; RADU, 1983; TABACARU & BOGHEAN, 1989; SCHMALFUSS, 2003). **Chorology**: Romanian endemite.

Metaliferi Mountains (Valea Ampoiului): Peşţera din Valea Bibarţului (= Peşţera din Valea Ghibarţului).

25. *Haplophthalmus tismanicus* Tabacaru, 1970 – Troglobitic species (blind, depigmented). **Distribution**: Romania (TABACARU, 1970A; RADU, 1983; SCHMALFUSS, 2003). **Chorology**: Romanian endemite.

Vâlcan Mountains: Peşţera de la Mânăstirea Tismana.

26. *Haplophthalmus movilae* Gruia & Giurginca, 1998 – Troglobitic species (1 ommatidia, depigmented). **Distribution**: Romania (GRUIA & GIURGINCA, 1998; SCHMALFUSS, 2003). **Chorology**: Romanian endemite.

Dobrogea: Movile Cave.

Family **Buddelundiellidae** Verhoeff, 1933

27. *Buddelundiella serbani* Tabacaru, 1971 – Endogeous, possibly troglophile species (blind, depigmented). **Distribution**: Romania (TABACARU, 1971; RADU, 1983; SCHMALFUSS, 2003). **Chorology**: Romanian endemite.

Vâlcan Mountains: Near the Tismana Monastery and Peştera de la Tismana, in a thick layer of leaf-litter; as this species was not yet found inside a cave, its inclusion in our list of the cavernicolous Oniscidea of Romania may appear inappropriate, but, as TABACARU (1971) has pointed out, at the genus *Buddelundiella*, a complete depigmentation is found only at the troglobitic species from Liguria.

Family **Porcellionidae** Brandt & Ratzeburg, 1831

28. *Porcellionides pruinosus* (Brandt, 1833) – Trogloxene species (with eyes, pigmented). **Distribution:** Originally Mediterranean, synanthropically cosmopolitan (SCHMALFUSS, 2003). **Chorology**: Cosmopolitan.

South Dobrogea: Peştera de la Limanu (DUMITRESCU ET ALL., 1965).

29. *Leptotrichus pilosus dobrogicus* Radu, 1973 (=*Leptotrichus medius* Verhoeff, 1941 det. Tabacaru in DUMITRESCU ET ALL., 1965) – Trogloxene species (with eyes, 12–14 ommatidia, pigmented). **Distribution**: Romania; endemic for both North (Chervant – Măcin, Denis Tepe – Babadag) and South Dobrogea (Agigea, Eforie Sud, Movile area – Obanul Mare) (RADU, 1985; GIURGINCA & ĆURČIĆ, 2003).

Chorology: Romanian endemite.

South Dobrogea: Peştera de la Limanu (DUMITRESCU ET ALL., 1965).

Family **Trachelipidae** Strouhal, 1953

30. *Trachelipus trilobatus* (Stein, 1859) (*Trachelipus racovitzai*) – Troglophilous species (with eyes, pigmented). **Distribution**: Romania (RADU, 1985; SCHMALFUSS, 2003). **Chorology**: Romanian endemite.

Vâlcan Mountains: Peştera cu Războaie de la Isvarna (RADU, 1948);

Cerna Valley Basin: Peştera Gaura Ungurului, Peştera Hoţilor de la Băile Herculane, Avenul lui Adam, Peştera Ponorul Pecinişcăi.

31. *Trachelipus troglobius* Tabacaru & Boghean, 1989 – Troglobitic species (2–4 depigmented ommatidia, depigmented). **Distribution**: Romania (TABACARU & BOGHEAN, 1989; SCHMALFUSS, 2003). **Chorology**: Romanian endemite.

Dobrogea: Movile Cave.

Family **Armadillidiidae** Brandt, 1833

32. *Armadillidium tabacarui* Gruia, Iavorschi & Sârbu, 1994 – Troglobitic species (16–18 ommatidia with slight traces of pigment, white or pinkish-white). **Distribution**: Romania (GRUIA, IAVORSCHI & SÂRBU, 1994; SCHMALFUSS, 2003). **Chorology**: Romanian endemite.

Dobrogea: Movile Cave.

33. *Armadillidium versicolor quinqueseriatum* Verhoeff, 1901 – Troglophilous species (with eyes, pigmented). **Distribution**: Central Europe (Southeastern Germany, Austria, former Czechoslovacia, Hungary, Romania, former Yugoslavia, Bulgaria, Albania) (RADU, 1985; SCHMALFUSS, 2003).**Chorology**: Balkan – Central Europe.

Perşani Mountains (Vârghişului Valley): Caves no. 1, 3, 4, 5, 8, 10, 11, 14 (Peştera Mare de la Mereşti), 16, 17, 21, 22, 23, 24, 26, 32, 34, 35, 36, 38, 40 (ORGHIDAN & DUMITRESCU, 1962–1963, GIURGINCA & VĂNOAICA, 2007).

Sebeşului Mountains: Peştera Mică din Bordul Mare.

Family **Cylisticidae** Verhoeff, 1949

34. *Cylisticus convexus* (De Geer, 1778) – Trogloxene species (20–25 ommatidia, pigmented). **Distribution**: Europe and Asia Minor, introduced to Northern Africa and South America (RADU, 1985; SCHMALFUSS, 2003). **Chorology**: Cosmopolitan.

Central Dobrogea: Peştera de la Casian

South Dobrogea: Peştera de la Limanu (DUMITRESCU ET ALL., 1965).

Banatului Mountains: Peştera no. 1 and 2 de la Gura Ponicovei (presently underwater), Peştera Gura Ponicovei, Peştera Liliecilor, Peştera din Cârşia Lacina, Peştera Vraşka, Peştera Gaura lui Schimpfin, Peştera de la Pepa, Peştera lui Climente, Peştera Veterani, Peştera Gaura cu Muscă (NEGREA & NEGREA, 1977), Peştera de după Cârşă.

Family **Scleropactidae** Verhoeff, 1938

35. *Kithironiscus dobrogicus* Tabacaru & Giurginca, 2003 – Troglobitic species (blind, depigmented). **Distribution:** Romania, South Dobrogea (TABACARU & GIURGINCA, 2003; GIURGINCA, NAE & VĂNOAICA, 2009). **Chorology:** Romanian endemite.

South Dobrogea: the species was found in both drillings performed near Movile Cave down to a depth of -9m.

5. ORIGIN OF THE CAVERNICOLOUS ONISCIDEA FROM ROMANIA – ECOLOGICAL AND ZOOGEOGRAPHIC CONSIDERATIONS

For the biogeographic studies, the various animal groups present a very unequal importance, a fact noted a long time ago by J. von Ihering, Jeannel, Vandel and other authors. Albert Vandel had repeatedly insisted on the requirements implied by the biogeographic studies.

Only ancient groups with a great morphological stability, with narrow ecological requirements and a low dispersion capacity, may provide important data regarding the origin and the history of the fauna from a specific region. But even within such groups, the expansive and synanthropic species should be eliminated from a historical biogeographic analysis.

The starting point of a biogeographic analysis is a real knowledge of the systematics of the studied group: valid results can be obtained only if the species

and their phyletic relationships are well defined. RACOVITZA (1912) considered the species as "an isolated colony of consanguins" and noted: "the definition of a species should be a synthesis of its morphological characters, its geographic distribution and its genealogy" (1926).

The Oniscidea, as an ancient group of terrestrial arthropods with morphological stability, low spreading possibilities and dependent in majority on certain humidity conditions, represent very good biogeographic indicators. Moreover, the cavernicolous Oniscidea can provide important data for the biogeographic analyses. In his study of the terrestrial Isopoda, RACOVITZA (1908) pointed out the presence in the subterranean domain of numerous archaic forms, real markers of ancient colonies of types extinct in the epigeous environments. In 1926, in an analysis on the results of the revisions published in *Biospeologica*, Racovitza emphasizes not only the abundance and the variety of the cavernicolous species but also, the remarkable proportion among the cavernicoles of relicts from ancient faunas extinct from the epigeous. Both Racovitza and Jeannel use for these troglobitic relicts, the term "living fossils" introduced by Darwin.

But the cave fauna contains, in fact, very different forms. In his famous «Essai sur les problémes biospéologiques», study regarded as "the birth certificate of the biospeleology" RACOVITZA (1907, p. 379) says: "What does the word cavernicole mean? Only this: living beings inhabiting the subterranean environment. The only thing that these beings have in common is their habitat. The cave fauna is, in fact, an absolutely heterogeneous mixture of very different forms in origin, hereditary aptitudes, their degree of organization, time of immigration in cave, etc."

If we analyze the cavernicolous Oniscidea of Romania from the point of view of their relationship with the cave environment, we note the great differences among the species and they can be grouped in the following categories:

1. A species intensely pigmented with big, pigmented eyes, formed by a great number of ocelli: *Ligidium hypnorum*. It is a frequent species in Romania and it is found in the first passages of very humid caves as it is a highly hygrophilous species.

2. Pigmented species with pigmented visual apparatus: *Hyloniscus riparius*, *H. dacicus*, *H. transsylvanicus*, *Trichoniscus carpaticus*, *Cylisticus convexus*, *Trachelipus trilobatus*, *Leptotrichus pilosus*, *Armadilidium versicolor*. These species are found only at the entrance and in the first passages of the caves.

3. Weakly or completely depigmented species, but with pigmented visual apparatus: *Androniscus roseus*, *Hyloniscus flammuloides, Stylohylea bosniensis, Trichoniscus inferus*, *T. dancaui*, *Haplophthalmus movilae*, *Monocyphoniscus babadagensis*, *Armadillidium tabacarui*. We have to note that *H. movilae*, *T. dancaui* and *A. tabacarui* have been found only in caves, the other species – in caves, but also outside them.

4. A species completely depigmented and without visual apparatus, but which was found in the endogeous: *Buddelundiella serbani*. It is an endogeicolous, endemic relict, strictly localized in a station with a thermophylous character and with Sub-Mediterranean floristic elements. We specify that depigmented and blind species of *Buddelundiella* have been found only in caves. Besides, VANDEL in his biospeleology treaty (1964, p.163) points out that it would be completely artificial to establish a precise separation between the endogeous and the cavernicolous species.

5. A species completely depigmented and without visual apparatus living preferentially in caves, often in abundant populations, but is also found outside caves: *Mesoniscus graniger*. RACOVITZA (1907, p.481), analyzing the hypothesis of a possible return of the cavernicoles to their original habitat, gives examples of epigeous species with cavernicolous ancestors. Regarding *Mesoniscus alpicola* Heller, he says: "if its normal station is really under rocks at surface, it is very probably also from a cave founder". VANDEL (1964) points to numerous examples of cavernicoles found normally or occasionally outside the subterranean environment and mentions *Mesoniscus* as a species living both in caves and under big stones in the endogeous.

6. Troglobitic species completely depigmented and without visual apparatus, but belonging to genera containing also pigmented species with a functional visual apparatus: *Trichoniscus racovitzai, T. tuberculatus, T. vandeli, Haplophthalmus caecus, H. tismanicus, Trachelipus troglobius*. All these species are endemic troglobites but they are included in genera with a wide spreading and containing species completely pigmented and with ocelli. *Trachelipus troglobius* is the only troglobitic species of the genus *Trachelipus*.

7. Troglobitic species, completely depigmented and without visual apparatus, belonging to genera containing only troglobitic species or are monotypic genera: *Caucasonethes vandeli, Biharoniscus racovitzai, Biharoniscus fericeus, Banatoniscus karbani, Kithironiscus dobrogicus*; the species *Thaumatoniscellus orghidani* should also be included here, although it was found in the lithoclasicolous at the entrance of a cave. All these species are endemic troglobitic relicts belonging either to endemic genera (*Biharoniscus*, *Banatoniscus*) or to genera with a disjunctive spreading (*Caucasonethes*, *Thaumatoniscellus*, *Kithironiscus*).

In order to analyze the origin and the history of the fauna of cavernicolous Oniscidea of Romania, we have to examine the relationships with the probable centers of origin and dispersion, respectively centers from the Egeida.

The literature data allow us to draw a comparison between the fauna of cavernicolous Oniscidea of Romania with the fauna of Bulgaria and that of Croatia.

Concerning Bulgaria, we have to note in the first place the high number of species, respectively 104 following the data provided by STOITZE ANDREEV (2002). The Oniscidea from Bulgaria have been studied by K. W. Verhoeff, H. Strouhal, Z. Frankenberger, A. Vandel and especially by S. Andreev.

Bulgaria has a great number of caves in the Balkan Mountains (Stara Planina) and in the Rhodope Mountains. Beginning from 1922, they have been intensely

explored under from a biospeleological point of view by I. Buresch, then after the war, by P. Tranteev, P. Beron, V. Gueorguev, V. Beshkov. A. Popov, H. Delcev, S. Andreev and more recently by B. Petrov, P. Stoev and T. Ivanova.

As P. BERON (2007) points out, there are 50 species of terrestrial Isopoda in the Bulgarian caves, 23 of them can be regarded as troglobitic. The majority have been discovered in caves from Stara Planina and the Rhodopes, but some of them in caves from isolated stations (the Ruse, Blagoevgrad and Strandja regions). Among the troglobitic species, 21 species belong to the Trichoniscidae family (17 Trichoniscinae and 4 Haplophthalminae) and 2 species are included in the Styloniscidae family. Characteristic for the cavernicolous fauna of Bulgaria are the endemic genera *Bulgaronethes* Vandel, 1967, *Balkanoniscus* Verhoeff, 1926, *Bureschia* Verhoeff, 1926 and *Rhodopioniscus* Tabacaru, 1993. The genus *Bureschia* presents a special interest due to its amphibious way of life and the peculiarities of its mouthparts in connection with its biology. Also, we have to note the troglobitic genera *Tricyphoniscus* Verhoeff, 1936, *Bulgaroniscus* Vandel, 1965, *Beroniscus* Vandel, 1967 and *Vandeloniscellus* Tabacaru, 1993 from the subfamily Haplophthalminae. The presence in the Bulgarian fauna of the Styloniscidae family (the genus *Cordioniscus*) is especially significant as it points out a certain affinity with the Gondwanian fauna and it is absent from the Romanian fauna and that of the Dinarids.

In contrast, in the fauna of Romanian caves (Dobrogea) we find troglobitic species from the Trachelipodidae, Armadillidiidae and Scleropactidae which have no troglobitic representatives in Bulgaria. The presence of the family Scleropactidae (*Kithironiscus* Schmalfuss, 1995) in Romania points to South-Egeidian and Gondwanian affinities.

The Oniscidea of Serbia have been studied by A. Buturovic, Mladen S. Karaman, F. Potocnik, Milika Pljakic, Ivo M. Karaman but the data do not allow us to draw a detailed comparison as there is no synthesis while the *Hyloniscus* and especially the *Trichoniscus* species described from Serbia need a revision. ĆURČIĆ & DECU (2008) list 13 Trichoniscidae from the Serbian caves, but do not specify the troglobitic species. However, we have to point out the remarkable presence in Western Serbia of the species *Alpioniscus metohicus* (Pljakic, 1970) and, especially, the species *Microtitanethes licodrensis* Pljakic, 1977, belonging to the genus *Microtitanethes*, from a group of Dinaric troglobionts (*Titanethes*, *Cyphonethes*, *Microtitanethes*) a group defined by the conformation of the endopodite of the first pleopode (TABACARU, 1993).

The spreading of the species (some troglophilic, others strictly troglobitic) from the group *Trichoniscus inferus* underlines an affinity between the fauna of Oniscidea from the caves of Romania with that of Bulgaria (Stara Planina) and that of Serbia. In 1965, Albert Vandel redescribed the species *Trichoniscus bureschi* Verhoeff, 1926 (spread in caves from Western and Central Stara Planina) and pointed out that the species *Trichoniscus inferus* described from Rauberhöhle (Peştera Hoţilor) from Băile Herculane thermal spa was not found again and that

based on the Verhoeff's description the two species cannot be differentiated. Only after half a century from the description of *T. inferus*, following a period of persistent rainfall, one of the authors (I. Tabacaru) recorded the species in the type locality, represented by a numerous population at the end of the cave around a rimstone formation.

First of all, we could verify the composition of the ocular apparatus at *T. inferus*: as Vandel has supposed, there are 3 ocelli and not 2 as Verhoeff pointed out. As a matter of fact, in the Trichoniscidae, there are genera with 3 small ocelli (*Trichoniscus*, *Tachysoniscus*, *Sicilioniscus*, *Stylohylea*, *Escualdoniscus*, *Psachonetes*, *Chasmatoniscus*), genera with 1 big ocellum (*Hyloniscus*, *Protonethes*, *Oritoniscus*, *Phymatoniscus*, *Trichoniscoides*, *Androniscus*, *Miktoniscus*, *Haplophthalmus*) and from both lines may derive the complete disappearance of the visual apparatus, so anophthalmous species, but there are no species with 2 ocelli. Also, by a detailed study of the individuals of *T. inferus* in comparison with the description given by Vandel for *T. bureschi* we could not find any distinctive characters. The characters recorded at the males of these species are found in populations of *Trichoniscus* spread in the Southern Carpathians in caves situated between the Oltului Valley and the Timiş-Cerna Corridor and at some species described from Serbia by M. A. Pljakic (*T. naissensis*, *T. serboorientalis*, *T. licodrensis*). This group of species (named by us the *Trichoniscus inferus* group after the first species described) can be defined by the following characters: pereiopode 7 male with a brush of curved scales on the sternal-distal edge on the caudal margin; pleopode 1 male has a triangular exopodite with the external side strongly concave delimitating a basal part laterally prolonged by a rectangular or trapezoidal lobe and a narrow terminal part with a rounded apex and lacking hairs; the distal article of the pleopode 1 endopodite without hairs and with more or less obvious transversal striae in the terminal part.

The populations recorded from the Cerna Valley caves (where the Băile Herculane spa is located) are more or less depigmented, but they have 3 pigmented ocelli. As they morphologically correspond with the individuals from Peştera Hoţilor, we consider them as belonging to the species *Trichoniscus inferus* Verhoeff, 1908.

The detailed analysis of the populations from the caves situated between the Oltului Valley and the Cerna Valley, led to the discovery of four new species belonging to the same group of species (as the male characters are corresponding), but are differentiated by the presence of characteristic glandular-piliferous organs (*T. racovitzai* Tabacaru, 1995, *T. tuberculatus* Tabacaru, 1996, *T. vandeli* Tabacaru, 1996 and *T. dancaui* Tabacaru, 1996). Still problematic is the species identity of the completely depigmented and without ocelli populations (also lacking glandular-piliferous organs) found in caves from Northern Oltenia (*Trichoniscus* aff. *inferus*). In numerous captive breeding experiments made in the laboratory from Cloşani Cave, we have tried to crossbreed individuals from these populations with individuals from *Trichoniscus inferus*, but no hybrids were obtained and as such, it seems they are not interfertile.

As a consequence, we consider that the species *T. inferus*, *T. dancaui*, *T. bureschi*, *T. naissensis* and *T. licodrensis* (with 3 pigmented ocelli) are probably troglophilous, while the species *T. racovitzai*, *T. tuberculatus*, *T. vandeli*, *T. serboorientalis* and *T.* aff. *inferus* (completely depigmented and without a visual apparatus) are strictly troglobitic. Generally, in caves there is only one species from the *inferus* group with the exception of Cloşani Cave, where there are two: *T. dancaui* (in the corridors close to the entrance) and *T.* aff. *inferus* (in the deepest part of the cave).

Also, we have to note the similarity between the species *Hyloniscus flammuloides* Tabacaru, 1972 and *Hyloniscus flammula* Vandel, 1965, described from Bulgaria and the sole troglobitic species of the genus *Hyloniscus*.

From the point of view of the karst and the cavernicolous fauna, Croatia is one of the most interesting regions of Europe. There is a high number of terrestrial Isopoda in the fauna of Croatia: J. Bedek, St. Taiti & S. Gottstein list 130 species and 30 subspecies, among which 57 species and 17 subspecies are endemic for Croatia. The Oniscidea of Croatia have been studied by K. W. Verhoeff, A. Arcangeli, A. Kesselyak, H. Strouhal, Z. Frankenberger, A. Vandel, A. Buturovic, Mladen Karaman, F. Potocnik, Ivo M. Karaman, St. Taiti and J. Bedek.

The catalogue of the Croatian fauna of Oniscidea of J. BEDEK, ST. TAITI & S. GOTTSTEIN (2011) lists 35 species and 5 subspecies of troglophile and troglobitic species of Oniscidea found in 557 caves. 19 species and a subspecies are regarded as troglobitic, all belonging to the Trichoniscidae family (16 species of Trichoniscinae, 2 species of Haplophthalminae and one of Thaumatoniscellinae).

A characteristic of the Croatian fauna of cavernicolous Oniscidea is the high number of species from the genus *Alpioniscus* Racovitza, 1908. This genus is represented only by troglobitic species spread from Spain (Catalonia) to the Greek mainland and islands, but the highest number of species is known from the caves of the Dinarids.

But the spreading of the genus does not pass eastwards beyond the Morava Corridor, in the Carpathians or in the Balkans. The genera *Aegonethes* Frankenberger, 1938, *Titanethes* Schiödte, 1849, *Cyphonethes* Verhoeff, 1926, *Strouhaloniscellus* Tabacaru, 1993 are characteristic for the Dinarids, but they also do not pass eastwards beyond the Morava Corridor and are absent from Serbia, Bulgaria and Romania.

The Romanian fauna of cavernicolous Oniscidea and that of Croatia have in common the presence of the troglophile species *Mesoniscus graniger* and *Androniscus roseus*. A remarkable fact is the discovery from a cave in Northern Croatia of the species *Thaumatoniscellus speluncae* Karaman, Bedek, Horvatovic, 2009 belonging to the genus *Thaumatoniscellus* Tabacaru, 1973 (Thaumatoniscellinae subfamily) known initially only from the Southern Carpathians with the species *Thaumatoniscellus orghidani* Tabacaru, 1973.

ALBERT VANDEL (1969) remarked that the biogeographic data resulting from the study of the spreading of the terrestrial Isopods agree perfectly with those resulting from the study of the Diplopoda, as Karl Strasser had formulated them.

VANDEL points out: "Il ne s'agit là d'un hazard. Cet accord prouve que, lorsque le biogéographe fait appel à des indicateurs présentant le même mode de vie, et possedant des moyens de dispersion analogues, l'analyse systématique et biogéographique conduit à formuler des conclusions analogues, sinon identiques".

The biogeographic researches regarding the cavernicolous Diplopoda from Romania (TABACARU, 1968; TABACARU, GIURGINCA, VĂNOAICA, 2003) and those regarding the Carpathians, the Balkan Peninsula or Europe (TABACARU, 1969, 1970B, 1970C) allow us to draw a comparison with the data resulting from the study of the cavernicolous Oniscidea.

Fig. 1. Biogeographic barriers for the Oniscidea of Romania: 1. Timok Valley; 2. Timiş-Cerna Corridor; 3. Mureş River; 4. Olt River.

Although the cavernicolous Diplopoda are represented by a higher number of species than the cavernicolous Oniscidea, there are a series of aspects obviously common between the two groups.

In the first place, for both groups, Romania, respectively the Banatului Mountains, the Southern Carpathians, the Apuseni Mountains and Central Dobrogea, mark the northernmost limit of the spreading of the various phyletic lineages with troglobitic representatives.

Similarly, we can note the existence of the same barriers separating the spreading of the various lineages. Just like in the case of the troglobitic Diplopoda, the troglobitic Oniscidea have not been found in the Southern Carpathians, east of the Olt Valley. JEANNEL (1931, 1943) was the first to emphasize the importance of

the Olt Valley as a biogeographic barrier limiting the spreading of the troglobitic fauna in the Southern Carpathians.

On the other side, as we have pointed out for the Diplopoda (DANCĂU & TABACARU, 1964, 1969; TABACARU, 1969), the Timiş-Cerna Corridor separates distinctly different troglobitic lineages. Regarding the Oniscidea, the Banatului Mountains harbor the haplophthalmid *Banatoniscus karbani*, while the Southern Carpathians the species *Haplophthalmus tismanicus* and especially the group *Trichoniscus inferus*, among which *T. racovitzai*, *T. tuberculatus* and *T. vandeli* are strictly troglobitic. The Mureş Corridor separates to the north, in the Apuseni Mountains, the troglobitic oniscids *Haplophthalmus caecus* and the genus *Biharoniscus* with two species – *B. racovitzai* and *B. fericeus*. As we have seen, there are, just like in the case of the Diplopoda, separate affinities, on the one side with Stara Planina and with the South-Danube Carpathians (*Hyloniscus flammuloides* and with the group *Trichoniscus inferus*) and on the other side with the Dinarids (*Thaumatoniscellus*).

Similarly with Diplopoda, in Dobrogea, we find completely different lineages of cavernicolous Oniscidea than in the Carpathians, pointing to affinities with other regions. Thus, in the caves of Dobrogea we find the genus *Caucasonethes* Verhoeff, 1932, a genus represented in the Caucasus Mountains by one species, *Caucasonethes borutzkyi* Verhoeff, 1932, and one species in Dobrogea – *Caucasonethes vandeli* Tabacaru, 1993. Closely related (perhaps synonymous) with *Caucasonethes*, is the genus *Tauronethes* Borutzky, 1949 with the species *T. lebedinskyi* Borutzky, 1949 in a cave from Crimea. The genus *Kithironiscus* Schmalfuss, 1995 has one species in the Kithira Island (*K. paragamiani* Schmalfuss, 1995) and another one in Southern Dobrogea – *K. dobrogicus* Tabacaru & Giurginca, 2003. Also endemic for the fauna of Dobrogea, are the species *Haplophthalmus movilae*, *Trachelipus troglobius* and *Armadillidium tabacarui*.

These affinities with the Dinarids, the Eastern Balkan Peninsula and with the Caucasus and Crimea points to the origin of the lineages of the troglobitic Romanian Oniscidea, respectively from centers of origin from the fauna of the landmass called Egeida by Jeannel.

The troglophilic (or perhaps originally troglobitic) *Mesoniscus graniger* raises special problems in contrast with the troglobitic Oniscidea at which we can argue (similarly with the troglobitic Diplopoda) a migration northward of their ancestors considering their centers of origin in the Egeidian landmass. The northern spreading limit of *M. graniger* does not coincide with the northern spreading limit of the troglobitic Oniscidea, as it reaches the Northern Carpathians. The genus *Mesoniscus* Carl, 1906 includes two species (GRUNER & TABACARU, 1963): 1. *M. alpicola* (Heller, 1858) is found in the Alps, respectively in the Lombard Alps (Italy) and especially in the North-eastern Alps (Austria); 2. *M. graniger* (Frivaldsky, 1865) spread in the entire Carpathian chain, beginning from the Northern Carpathians (Slovakia), the Romanian Carpathians, South-Danube

Carpathians (Serbia), the Dinarids (Serbia, Bosnia and Hertzegovina) and the Julian Alps (Slovenia and Italy) (GIURGINCA, 2005, 2009).

There are various hypotheses on the origin of *M. graniger*. Based on morphological-systematic reasons, TABACARU (1969) at the Vth Speleological Congress, considered the species *M. alpicola* as the more primitive and so the Alps are probably the center of origin of the genus which leads to the question if *M. graniger* has a Northern Carpathian origin and from there it migrated southward along the Carpathian chain to the Dinarids and the Julian Alps or, of contrary, it has a South Alpine – Illyric origin and migrated northward from the Dinarids to the Carpathians up to the Northern Carpathians. M. PLJAKIC (1977) suggests two possibilities: a). from its original spreading area (Dinarids), *M. graniger* had migrated to the Carpathians in Eastern Serbia and from there further on in the Romanian Carpathians up to the Northern Carpathians; b). the ancestor of the genus *Mesoniscus* had inhabited the entire present-day areal of the genus, but the evolution of the Paratethys led to the separation and the evolution of two distinct species. In our opinion, the emergence of the species *M. graniger* in its entire areal (so wide and so fragmented in time) is highly improbable and that there should have been a center of origin. After a detailed analysis of the spreading and the migration of this species, A. GIURGINCA (2005, 2009) argues strongly for a southern (Illyric) origin of the species *M. graniger* based on the presence of land-bridges between the Alps and the Dinarids before the formation of the Alps-Bohemian Massif-Carpathians connection. The subsequent isolation of the Dinarids from the Alps and also from the Carpathians further enforces this hypothesis. Therefore, we might regard the species *M. graniger* as an ancient Dinaric element and not a Carpathian one.

This migration, from a South-East Alpine – North Dinaric center, along the Dinarids up to the Carpathians, is similar to the migration, among Diplopoda, of the Typhloiulini tribe (TABACARU, 1970B; TABACARU, GIURGINCA & VĂNOAICA, 2003). But the Typhloiulini cross eastwards into Stara Planina. Possibly, the migration of *M. graniger* was blocked by a corridor situated on the Timok Valley.

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"Emile Racovitza" Institute of Speleology
13 Septembrie No. 13,050711, Bucharest
E-mails: *igtabacaru@yahoo.com, sankao2@yahoo.com*